PB82-102500

Federal Initiative for Clean Air Inspection and Maintenance

PEDCo-Environmental, Inc.
Kansas City, MO

Prepared for

Environmental Protection Agency
Kansas City, MO

Feb 81

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It is the responsibility of the Federal Motor Vehicle Control Program to regulate new car emissions and to ensure the production of vehicles that, if properly maintained, will meet applicable emission standards throughout their useful life. As a complementary program, inspection/maintenance (I/M) aims at the control of motor vehicle emissions and the reduction of air pollution through required periodic inspection of motor vehicles and maintenance of those that do not pass inspection. The U.S. Environmental Protection Agency (EPA) estimates that a properly operated designed I/M program can reduce auto air pollution emissions by 20-30 percent after several years of program implementation.

KEYWORDS: *Air pollution control, *Inspection, *Maintenance, *Exhaust emissions, *Clean Air Act Amendments of 1970.

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Inspection and Maintenance

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FEDERAL INITIATIVE FOR CLEAN AIR:

INSPECTION AND MAINTENANCE

Errata

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QUALITY ASSURANCE PROCEDURES

Two Hamilton Test Systems Emission Analyzers, Model No. CEA 600, were used in the testing. This model meets the specifications in Section 207(b) of the 1977 Clean Air Act Amendments, as well as the 1980 requirements of the California Bureau of Automotive Repair. One unit was used while the other served as a backup. At the beginning of the testing period, both analyzers were fully calibrated by using the manufacturer's specified procedure and a test gas. Two subsequent calibration tests performed at 6-week intervals indicated that no adjustments were required. A full calibration was performed again at the completion of testing.

Other quality assurance procedures used during the data analysis are reviewed in Section 3.

FEDERAL INITIATIVE FOR CLEAN AIR--
INSPECTION/MAINTENANCE

by

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Contract No. 68-02-2535
Task Order No. 22
PN 3280-V

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February 1981

DISCLAIMER

This Final Report was furnished to the U.S. Environmental Protection Agency by PEDCo Environmental, Inc., Cincinnati, Ohio in fulfillment of Contract Number 68-02-2535. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency or of cooperating agencies. Mention of company or product name is not to be considered as an endorsement by the Environmental Protection Agency.

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EXECUTIVE SUMMARY

BACKGROUND OF INSPECTION/MAINTENANCE

It is the responsibility of the Federal Motor Vehicle Control Program to regulate new car emissions and to ensure the production of vehicles that, if properly maintained, will meet applicable emission standards throughout their useful life. As a complementary program, inspection/maintenance (I/M) aims at the control of motor vehicle emissions and the reduction of air pollution through required periodic inspection of motor vehicles and maintenance of those that do not pass inspection. The U.S. Environmental Protection Agency (EPA) estimates that a properly operated designed I/M program can reduce auto air pollution emissions by 20 to 30 percent after several years of program implementation.

The Clean Air Act Amendments of 1977 require the establishment of I/M programs in urban areas where National Ambient Air Quality Standards (NAAQS) for photochemical oxidants and/or carbon monoxide (CO) cannot be met by December 31, 1982. In Region VII, projections indicate this requirement will affect St. Louis and Wichita. Although Kansas City is now classified as nonattainment for oxidants, attainment is expected to be achieved before the end of 1982.

In 1979 the State of Missouri passed enabling legislation for mandatory I/M programs in St. Louis and Kansas City. The Missouri State Implementation Plan (SIP) commits to a mandatory I/M program beginning no sooner than July 1, 1981, and no later than December 31, 1982. (A mandatory I/M program is scheduled to begin in St. Louis on January 1, 1982.) The Missouri SIP further requires a voluntary I/M demonstration program to prepare the public for the mandatory program and to gather data for a Report to the Legislature on the recommended type of I/M program to be implemented (e.g., model years covered, exemptions, and the like).

Wichita is not expected to meet the NAAQS for CO until June 1983, 6 months past the required date. When submitted, the Kansas SIP is expected to commit to the establishment of a voluntary I/M program to begin in January 1981. It is believed that an overall 10 percent participation in this program with 10 percent of the failing vehicles being repaired (coupled with

other planned transportation control measures) would make attainment possible by the required 1982 date.

FEDERAL INITIATIVE

Region VII of the EPA developed the Federal Initiative for Clean Air for areas that are not currently meeting NAAQS. The Federal Initiative recommends that all Federal employees have their cars inspected for excessive CO and hydrocarbon (HC) emissions, and that similar inspections be made on all vehicles in the Federal vehicle motor pool. This Federal Initiative was subsequently endorsed by the Federal Regional Council (FRC), and the Greater Kansas City Federal Executive Board (FEB) The St. Louis Federal Executive Board (FEB), and the Wichita Federal Executive Association (FEA). The FEB's and FEA Energy Committees sponsored the program described in this report, and EPA Region VII provided the resources to perform the inspection/maintenance testing.

PURPOSE

This study has a fourfold purpose:

1. To implement the Federal Initiative to test Federal employee vehicles.

2. To implement in part a voluntary I/M program (as provided for in the Missouri SIP) to prepare the public for the mandatory program.

3. To provide the State of Missouri and the City of Wichita with in-use vehicle emission data.

4. To provide the State of Missouri and the city of Wichita with materials with which to conduct I/M testing.

METHODOLOGY

The basic procedure consisted of testing vehicles at major Federal installations and statistically analyzing the data collected. All major Federal installations were contacted to arrange a date for the I/M testing. At installations desiring to participate, two persons from PEDCo set up a testing area and performed the inspections. Data on each vehicle and the results of the test were transcribed onto data forms. These data were keypunched directly from the forms and then analyzed by computer program. Before the testing, interest in the volunteer program

was generated by distributing posters and information sheets at each Federal installation, and, where possible, by having announcements made over public address systems. Federal employees who took part in the program received an information booklet and, if their vehicle passed the inspection, a decal.

During the course of the study, PEDCo followed several quality assurance procedures to ensure the accuracy of the results. These procedures included frequent calibration of testing equipment and an extensive edit program to check all the data generated by the project.

RESULTS

A total of 2658 vehicles were tested. Table I summarizes the results of these tests, and Table II presents a breakdown of the results by city and agency.

TABLE I. SUMMARY OF INSPECTION/MAINTENANCE TESTING RESULTS

	Total vehicles tested	Number passing test	Percent passing test
All locations[a]	2655[b]	1927	72.6
Kansas City, Missouri, area	1103	776	70.4
St. Louis, Missouri, area	379	254	67.0
Wichita, Kansas, area	601	449	74.7

[a] Includes Scott Air Force Base (Illinois) and Leavenworth and Kansas City, Kansas, data not included in other tabulations.

[b] Data on three tested vehicles could not be recovered.

The testing period lasted 43 days and involved the participation of 47 agencies at 24 locations. The proportion of vehicles that passed the test varied by area (67.0 to 74.7 percent), but 73 percent of the total number passed. At agencies where more than 10 cars were tested, the proportion of passing vehicles ranged from 53.5 to 100 percent.

An original objective of the study was to retest vehicles that failed the initial inspection after they had been repaired to correct the cause of the failure. Perhaps because the program was voluntary, an adequate data base of retest information could not be obtained.

TABLE II. AGENCY PARTICIPATION AND PASS/FAIL INFORMATION

Agency name	Tested No. of vehicles	No. of passing	Percent passing	Percent failing
Kansas City, Missouri				
Army Hometown News	3	1	33	67
Community Services Administration	2	2	100	
Corps of Engineers	18	15	83.3	16.7
Customs Service	18	13	72.2	27.8
Defense Investigative Services	7	7	100	
Department of Agriculture	329	221	67.2	32.8
Department of Commerce	5	2	40	60
Department of Defense	1	1	100	
Department of Defense, Mapping	43	23	53.5	46.5
Department of Education	1	1	100	
Department of Energy	2	2	100	
Department of Interior	1	1	100	
Environmental Protection Agency	28	28	100	
Environmental Protection Agency, Lab	28	20	71.4	28.6
Federal Aviation Administration	41	30	73.2	26.8
Federal Highway Administration	43	28	55.1	34.9
Fish and Wildlife Service	15	8	53.3	46.7
Food and Drug Administration	16	16	100	
General Services Administration (Federal Building)	141	84	59.5	40.5
Government Vehicles	32	21	65.6	34.4
Kansas City, Missouri, Employees and Motor Pool	113	78	69.0	31.0
National Highway Traffic Safety Administration	4	2	50	50
National Oceanic and Atmospheric Administration	11	8	72.7	27.3
National Transportation Safety Board	3	3	100	
National Weather Service (Federal Building)	1	1	100	
National Weather Service (Hardesty)	12	9	75	25
Social Security Commission	7	7	100	
University of Missouri--Kansas City, Truman Library	18	8	100	
Urban Mass Transit Administration	8	6	75	25
VA Hospital--Leavenworth	92	83	90.2	9.8
Veterans Administration Hospital	66	63	98.5	1.5
Other	121	84	69.4	30.6
Subtotal	1,223	880	72.0	28.0

(continued)

TABLE II (continued).

Agency name	Tested No. of vehicles	No. of passing	Percent passing	Percent failing
St. Louis, Missouri				
Army	69	45	65.2	34.8
Army Reserve Components Personnel and Administration Center	83	53	63.9	36.1
Civil Service Commission	3	2	66.7	33.3
Department of Agriculture	4	4	100	
General Services Administration	74	49	66.2	33.8
Government Vehicles	2	2	100	
Occupational Safety and Health Administration	7	7	100	
Post Office	1	1	100	
Scott Air Force Base	452	355	78.5	21.5
Veterans Administration	7	6	85.7	14.3
Veterans Administration--Jefferson Barricks	113	71	62.8	37.2
Other	16	14	87.5	12.5
Subtotal	831	609	73.3	26.7
Wichita, Kansas				
General Services Administration	12	11	91.7	8.3
Government Vehicles	18	16	88.9	11.1
Internal Revenue Service	93	86	92.5	7.5
McConnell Air Force Base	208	140	67.3	32.7
Occupational Safety and Health Administration	15	15	100	
Small Business Administration	9	8	88.9	11.1
Social Security Administration	9	8	88.9	11.1
Veterans Administration Center	237	165	69.6	30.4
Subtotal	601	449	74.7	25.2

SECTION 1

INTRODUCTION

BACKGROUND

Requirement for Inspection/Maintenance

The intent of the Clean Air Act Amendments of 1970 was to achieve attainment of National Ambient Air Quality Standards (NAAQS) throughout the United States. Because automobile exhausts are responsible for almost all the concentrations of carbon monoxide, about half of the hydrocarbons, and somewhat less than half of the nitrogen oxides found in the Nation's urban areas, these amendments mandated a 90 percent reduction in the current emission levels for all new cars, beginning with the 1975 models. Although the final compliance date has been delayed, a significant tightening of the applicable standards went into effect in 1975 and again in 1980.

By the mid-1970's, it had become apparent that the NAAQS were not being met. As a result, Congress mandated that all those areas in violation of these standards be designated as nonattainment areas. Congress further required that the States in which these areas were located revise their State Implementation Plans (SIP's) by 1979, with the goal of achieving attainment and maintenance of the NAAQS as soon as possible, and no later than December 31, 1982. If the 1979 SIP revision could not ensure attainment of NAAQS for oxidants and CO by 1982, a specific schedule for the implementation of inspection/maintenance would be required. The U.S. Environmental Protection Agency (EPA) estimated that within a few years a properly operated I/M program could reduce auto air pollution emissions by 20 to 30 percent.

State Response to I/M

Because the State Implementation Plans for Missouri and Kansas could not ensure attainment of the NAAQS in the St. Louis and Wichita areas by the specified date, an I/M program must be established in these areas.

In response to this need, the State of Missouri passed enabling legislation for a mandatory I/M program in St. Louis

and Kansas City (attainment in Kansas City was still uncertain at the time). The Missouri SIP committed to a mandatory I/M program to begin no sooner than July 1, 1981, and no later than December 31, 1982. (Mandatory testing in St. Louis is scheduled to begin on January 1, 1982.) The SIP further required a voluntary I/M demonstration program to prepare the public for the mandatory program and to gather data to report to the legislature on the recommended type of I/M program to be implemented (car model years covered, exemptions, etc). The State needs the following data to prepare the Report to the Legislature: in-use motor vehicle emissions data, achievable emissions reductions, repairs required to achieve reductions, cost of these repairs, and administrative resources necessary to run an I/M program.

Because Wichita cannot meet the NAAQS for CO until June 1983, 6 months past the required date, the Kansas SIP has committed to the establishment of a voluntary I/M program to begin in January 1981. It is believed that an overall 10 percent participation in this program with 10 percent of the failing vehicles being repaired (coupled with other planned transportation control measures) will make attainment possible by the required 1982 date.

Federal Initiative

Region VII of the EPA developed the Federal Initiative for Clean Air for areas that are not currently meeting the NAAQS. This initiative recommends that the personal cars of Federal employees be inspected for excessive CO and HC emissions and that all the vehicles in the Federal vehicle motor pool also be tested. The Federal Regional Council (FRC), the Greater Kansas City Federal Executive Board (FEB), The St. Louis Federal Executive Board (FEB), and the Wichita Federal Executive Board (FEA) subsequently endorsed the Federal Initiative. The FEB's and FEA Energy Committees sponsored the program described in this report, and EPA Region VII provided the resources to perform the inspection/maintenance testing.

STUDY PURPOSE

This study has a fourfold purpose:

1. To implement the Federal Initiative to test federal employee vehicles.

2. To implement in part a voluntary I/M program for the State of Missouri to prepare the public for the mandatory program.

3. To provide the State of Missouri and the City of Wichita with in-use motor vehicle emission data.

4. To provide the State of Missouri and the city of Wichita with materials to conduct I/M testing.

SECTION 2

SAMPLING METHODOLOGY

MATERIALS DEVELOPED

The basic study consisted of testing vehicles at major Federal installations and performing a statistical analysis of the data collected. The first step involved the development of several materials to publicize the program, to assist in the actual vehicle testing, and to educate motorists who would be participating in the voluntary program. These materials consisted of posters, a fact sheet, a data form, an informational brochure, and a decal. Appendix A contains copies of these materials. In addition to these written materials, 2 sets of indicator lights were fabricated for use during testing.

Seven to 14 days before the testing date 18 x 24 inch posters indicating the date, time, and location of the testing station were placed at one or more prominent locations at each Federal facility where testing was to occur. The fact sheets, which provided information about the need for I/M and its benefits to air quality and fuel economy, were also distributed. Where possible, these two types of printed material were supplemented by announcements over building public address systems before and on the testing date(s).

The data form, which is for recording testing results, was developed so that it could meet the needs of this voluntary testing program and the long-term needs of the mandatory St. Louis and Wichita I/M programs. The following items were recorded:

Initial Inspection Data

1. City number and test location
2. Cumulative test number
3. Date
4. Vehicle inspection number (VIN)
5. Model year
6. Make of automobile
7. Vehicle class
8. Mileage
9. Number of cylinders

10. Fuel type (unleaded or leaded gasoline)
11. Catalyst-equipped (yes or no)
12. Tested level of hydrocarbons (parts per million) and carbon monoxide (percent)

Retest Data

13. Mileage
14. Tested levels of hydrocarbons and carbon monoxide
15. Repair cost
16. Repair type

The city number and test location were recorded so that the data could be easily separated according to specific areas. Items 2 and 3 served as test identifiers. Items 4 through 11 served as vehicle information items that could be correlated with test results. When decoded, the VIN number gives vehicle characteristics. Item 12 is for actual test results. Retest data were collected to determine the types of repairs normally required and their effectiveness.

The informational brochure was prepared for distribution to each motorist who participated in the program. This 18-page, two-color booklet explained the program and how it works, and listed emission standards, the program benefits, likely causes of test failure, and steps to follow to reduce emissions. Space was provided on the front cover to record the results of the initial tests; the back cover contained spaces to record repair information and retest data. In addition to using the booklet for this I/M project, camera ready copies of the booklet were provided to the State of Missouri for their use.

In addition to the written materials, 2 sets of indicator lights were fabricated for use during actual testing. The indicator lights flashed "pass" or "fail" depending on the test results. To fabricate the lights, it was also necessary to modify the emission analyzers (Appendix D).

The decal was prepared for distribution to those motorists who passed the test.

TESTING LOCATIONS

The Federal Executive Boards of Kansas City, St. Louis, and Wichita sent letters to all Federal installations, requesting their participation in the voluntary I/M testing program. The letter requested that a representative of each installation contact PEDCo or EPA Region VII to arrange a testing date. As a followup, PEDCo contacted by phone all those Federal installations that did not respond to the letter. Some local governmental agencies that heard of the program also expressed a desire to participate.

The 43 days of testing took place at 24 locations and spanned a period from May 13 to September 17. Forty-seven government agencies participated, and a total of 2658 vehicles were tested. Testing locations, dates, and participation are summarized in Table 1.

TESTING PROCEDURES

Scheduling

Many of the coordinators at the Federal facilities attempted to schedule testing times so as to minimize lost work time resulting from long lines at the testing locations. Some sent sections or floors at a specified time; some sent three people at a time, with the next group of three leaving when the first group returned; and some printed and circulated schedules in which specific times were assigned to individuals. Generally, this scheduling was either ineffective or unnecessary. Often the persons scheduled did not come at the correct time or did not come at all. In other cases, the time increments could accommodate more persons than were scheduled, which resulted in ineffieicnt utilization of the testing facility. Motorists seldom had to wait more than 5 minutes, whereas slack periods at the testing location were often much longer.

Inspection

During the preliminary facility visits for distribution of posters and fact sheets, a PEDCo representative established the exact testing location and power source. The testing sites varied widely, and some were much better than others. Site requirements were as follows:

- Easily accessible to motorists
- Clearly visible
- Within 200 feet of a power source
- At least 30 feet wide
- At least 100 feet long (to accommodate waiting vehicles).

On the testing days, two persons from PEDCo arrived at the site about 45 minutes before the first scheduled test. This extra time was required to run extension cords from the power source to the emissions analyzer, warmup the analyzer for the required 8 minutes, setup signs in the area to guide motorists to the testing station, and setup cones to delineate the testing lane.

During the actual test, one person handled the probe and the other person talked to the driver and recorded the test

TABLE 1. SUMMARY OF INSPECTION/MAINTENANCE TESTS

Testing location	Agency	Testing dates	Number	
			At Agency	Cumulative
Independence and Hardesty, Kansas City, Missouri	Five agencies	May 13	80	80
EPA Laboratory, Kansas City, Missouri	EPA	14	28	108
63rd and Rockhill Road, Kansas City, Missouri	DOT	15		
	FHWA	16	86	194
75th and State Line, Kansas City, Missouri	DOA	27		
		28	96	290
Federal Building, 601 East 12th Kansas City, Missouri	COE	29	29	310
	FAA	30	34	344
Bannister Road, Kansas City, Missouri	GSA	June 4		
		5		
		6	84	428
89th and Ward Parkway, Kansas City, Missouri	DOA	9		
		10	198	
11th and Oak, Kansas City, Missouri	EPA	11	24	650
	EPA			
	DOE			
	Educ	12	31	681
NKC at FEB, Kansas City, Missouri	FEB			
	Customs	17	98	779
Federal Building, Kansas City, Missouri	Health Department	18	53	832
VA Hospital, Kansas City, Missouri	VA	19	66	898
Independence, Missouri	UMKC	30	7	905
VA Hospital, Leavenworth, Kansas	VA	July 10	114	1019

(continued)

TABLE 1 (continued).

Testing location	Agency	Testing dates	Number	
			At Agency	Cumulative
GSA Motor Pool, Wichita, Kansas	IRS SBA SS OSHA GSA	15 16 17	151	1170
VA Hospital Regional Center, Wichita, Kansas	VA	29 30 31	241	1411
City Hall, Kansas City, Missouri	All city employees	Aug 7 8	83 34	1494 1528
Records Center, St. Louis, Missouri	GSA	13 14	159	1687
Goodfellow, St. Louis, Missouri		18 19	92	1779
VA Hospital, St. Louis, Missouri	All	20 21	113	1892
Scott Air Force Base, St. Louis, Missouri	All	25 26	453	2345
Federal Mart, St. Louis, Missouri	All	27	15	2360
Federal Building, 601 East 12th Kansas City, Missouri	NTSB Dept. of Interior	Sept 3 4	42	2402
McConnell Air Force Base, Wichita, Kansas	All	9 10 11	209	2611
Bannister Road, Kansas City, Missouri	GSA	17	47	2658

results. When the car was in position, one person would greet the motorist and briefly explain the procedure while the other inserted the probe in the tailpipe. The HC and CO values on the emission analyzer, which was positioned so the motorist could see it, would stabilize within 30 seconds, and the results were locked in. "Pass" or "fail" indicator lights also were mounted on a pole for motorists to see. Test values were then written on the front of the motorist's information booklet and recorded on the data sheet, which was retained at the station. If the vehicle passed, the motorist received a decal and then pulled out of the testing lane. If the vehicle failed, the tester named some possible causes for the failure and some repairs that might reduce emissions and improve fuel efficiency. The photographs in Figure 1 show some of this testing procedure.

With two people, the actual testing can be accomplished in as little as 2 minutes; however, additional time should be allocated for explaining the program to all of the drivers and for explaining causes of failure to motorists whose vehicles do not pass. Therefore, 3 to 5 minutes should be allocated for each test. The maximum number of vehicles tested by a crew of two in an 8-hour day was 250. Because this rate of testing allowed almost no time to talk to the drivers, part of the educational value of the test was lost. A desirable maximum with a two-person crew is about 150 vehicles/day.

Alternate personnel arrangements are possible. For example, one person can operate a test station, but this increases the minimum actual testing time from 2 minutes to 3 minutes plus the extra time that should be allocated for educating drivers. A desirable maximum with a testing crew of one is 100 vehicles/day. Another alternative is a crew of three. With this setup, two people do the testing (with little tester-driver communication). After the test, drivers of vehicles that fail pull ahead to a designated spot, where the third crew member discusses the causes of failure with them. The desirable maximum with a testing crew of three is 225 vehicles/day.

QUALITY ASSURANCE PROCEDURES

Two Hamilton Test Systems Emission Analyzers, Model No. CEA 600, were used in the testing. This model meets the specifications in Section 207(b) of the 1977 Clean Air Act Amendments, as well as the 1980 requirements of the California Bureau of Automotive Repair. One unit was used while the other served as a backup. At the beginning of the testing period, both analyzers were fully calibrated by using the manufacturer's specified procedure and a test gas. Two subsequent calibration tests performed at 6-week intervals indicated that no adjustments were

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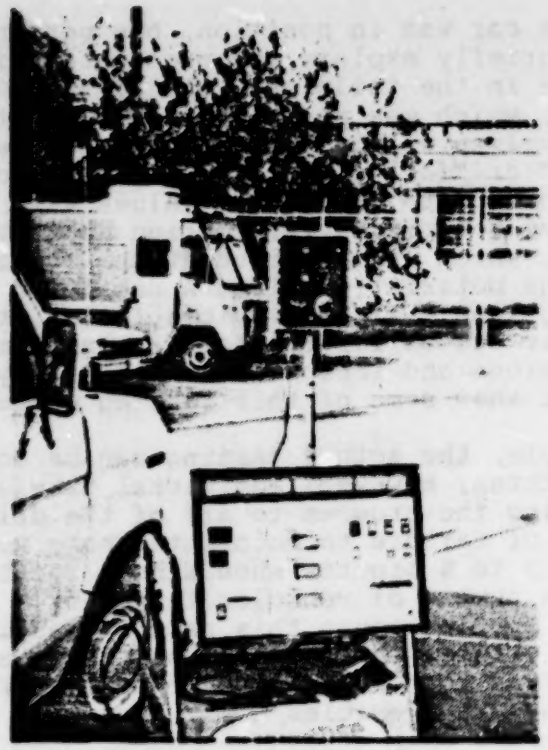

VIEW OF DRIVER WHILE IN CAR

VIEW OF THE TESTING LOCATION

Figure 1. Photographs of an Inspection Testing Location. (continued)

INSERTING THE PROBE

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DISCUSSING TEST RESULTS WITH A DRIVER

Figure 1. (continued)

SECTION 3

ANALYSIS METHODOLOGY

DATA VERIFICATION

The design of the data form used in the field was such that the data could be keypunched directly from the forms to cards and later transferred to magnetic tape. Not having an intermediate coding step eliminated transcribing errors.

The data on tape then underwent extensive data verification as a quality assurance procedure to ensure its integrity. The procedure involved three steps. The first was to check for the presence of alpha characters in numeric fields and vice versa, which caught both data entry and keypunch errors. The second step was to produce frequency distributions of all variables and compare the codes in the frequency distriubtion to their allowable values. For example, vehicle class codes were designed to range from 1 to 7; therefore, any other values were errors. The third step involved checking the data for errors in logic. For example, catalyst equipment variables were cross-tabulated with the model year variables. Since catalysts were not used until 1975, any vehicles made before that time could not have catalytic converters. Any errors in the records were corrected at the end of each of the three steps. Only three records could not be rectified.

DATA REQUIREMENTS

Separate data analyses were required for EPA and the State of Missouri.

EPA Data Requirements

The EPA wanted data that indicated agency participation in the Federal Initiative and the overall pass/fail rates. Therefore, a separate listing for each agency shows the number of cars participating, the number that passed, the percentage that passed, and the percentage that failed. This data was also aggregated by Federal Executive Board jurisdiction. Section 4 presents these tabulations.

State of Missouri Data Requirements

The State of Missouri required considerably more comprehensive data than did EPA. The procedure for generating these data is shown in Figure 2. Separate sets of data summaries were compiled for the Kansas City area and the St. Louis area. To minimize software requirements, PEDCo prepared like data summaries for Wichita. The State of Missouri requested the removal of the data for Scott Air Force Base (Illinois) and Leavenworth, and Kansas City, Kansas, because only data for in-state vehicles were desired for the analysis.

The five data summaries produced for each of the three data sets (Kansas City, St. Louis, and Wichita) were as follows:

1. Cross-tabulations of CO values versus HC values by different combinations of vehicle classes.

2. Cross-tabulations of CO values versus HC values by catalyst versus noncatalyst converter equipped vehicles.

3. Frequency distributions of vehicle characteristics.

4. Frequency distributions of HC and CO values.

5. Mean HC and CO values by percentile.

Selected data summaries are presented in Section 4, and additional data are presented in Appendix B. Complete data sets are available from Missouri Department of Natural Resources, P.O. Box 1368, 2010 Missouri Boulevard, Jefferson City, Missouri 65102; telephone (312) 751-3241.

Software Requirements

The data analyses listed above were performed with a series of computer programs entitled Statistical Package for the Social Sciences (SPSS). SPSS was chosen for these analyses for several reasons including:

1. The programs are inexpensive to run.

2. The programs were capable of performing all the analyses required by the State of Missouri.

3. The programs are readily accessible by the State.

Examples of the SPSS input statements needed for the data analyses are presented in Appendix C. For a complete description of the SPSS program the reader should refer to the SPSS user's manual.[1]

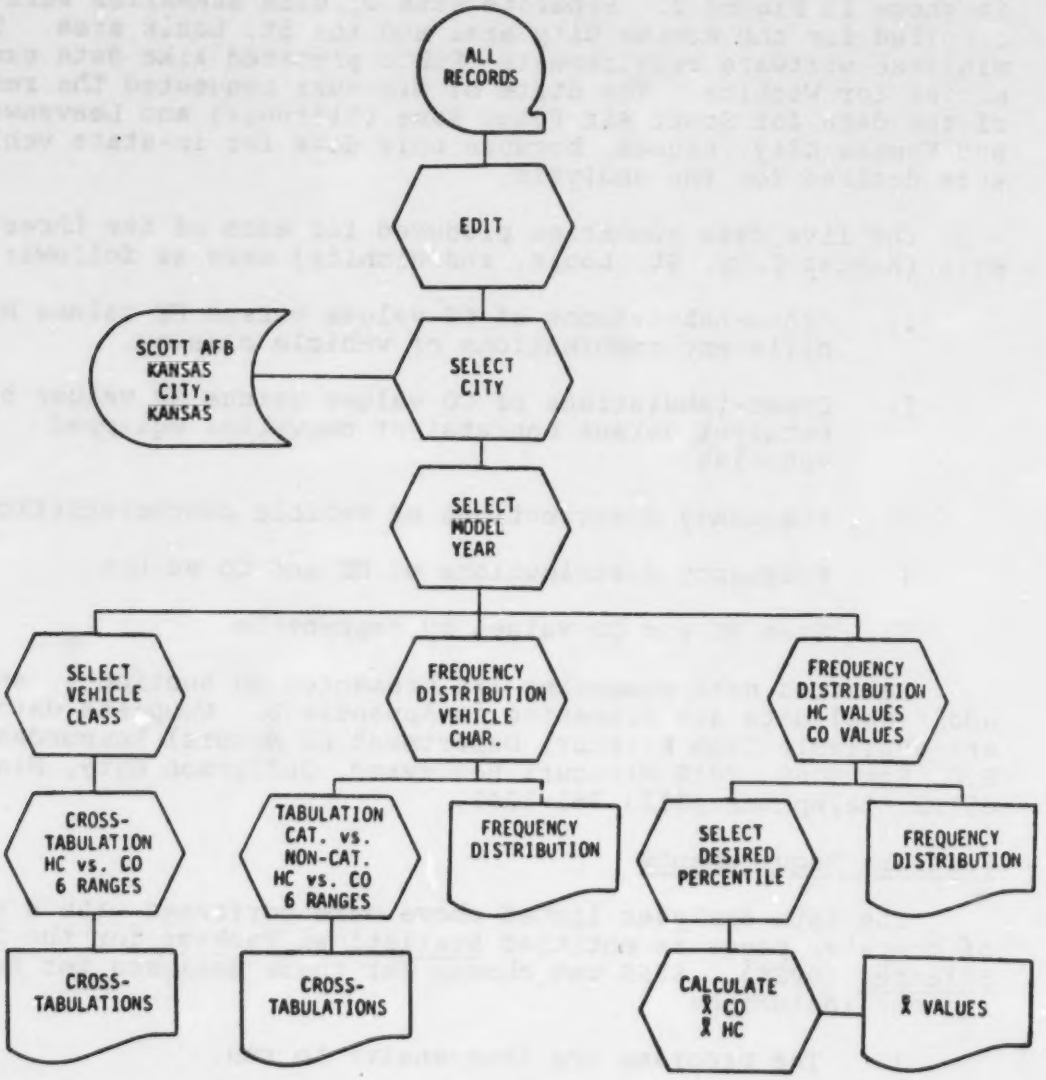

Figure 2. Data analysis for the State of Missouri.

SECTION 4

STUDY RESULTS

PASS/FAIL RATES BY LOCATION

A total of 2658 vehicles participated in the program. Because the records on three of these vehicles could not be processed, the data represent 2655 vehicles. The Kansas City, Missouri, area had the greatest number of participants (1103 vehicles). Table 2 summarizes total participation by location.

TABLE 2. PROGRAM PARTICIPATION BY LOCATION

	Number of vehicles
All locations[a]	2655
Kansas City, Missouri	1103
St. Louis, Missouri	379
Wichita, Kansas	601

[a] Includes Scott Air Force Base (Illinois) and Leavenworth and Kansas City, Kansas data, which are not included in the individual geographic areas at the request of the State of Missouri.

A vehicle passed the test if levels of carbon monoxide and hydrocarbons in the emissions were below the New Jersey Phase 2 inspection standards. As shown in Table 3, 72.6 percent of all the vehicles at the locations passed the test for both pollutants. Percentages of vehicles passing both tests did not vary much by geographic location (the range was 67.0 to 74.7 percent), but the greatest percentage of failure was in the St. Louis area. The breakdown by individual pollutant tests shows the percentage of vehicles passing the hydrocarbon test was higher than the percentage passing the carbon monoxide test. In the Wichita area, for example, the rate of failure on the hydrocarbon test was only 14.5 percent. Table 4 presents the distribution of carbon monoxide and hydrocarbon test results by location.

TABLE 3. VEHICLES PASSING INSPECTION BY LOCATION
(percentage)

	Passed[a] carbon monoxide	Passed[a] hydrocarbons	Passed both
All locations[b]	80.8	83.7	72.6
Kansas City, Missouri	79.1	81.8	70.4
St. Louis, Missouri	76.5	79.2	67.0
Wichita, Kansas	82.4	85.5	74.7

[a] Based on the following maximum levels from New Jersey Standards.

Vehicle age	CO, %	HC, ppm
1975 and newer	3.0	300
1970 to 1974	5.0	500
1968 and 1969	7.0	700
1967 and older	8.5	1,400

[b] Includes Scott Air Force Base (Illinois), and Leavenworth and Kansas City, Kansas, data.

TABLE 4. FREQUENCY DISTRIBUTION OF CO AND HC VALUES BY LOCATION
(number of vehicles)

	All locations[a]	Kansas City, Mo. area	St. Louis, Mo. area	Wichita, Kansas area
Total vehicles	2655	1103	397	601
Carbon monoxide, %				
0-1.00	1310	548	179	286
1.01-2.00	373	150	45	91
2.01-3.00	261	106	39	65
3.01-4.00	204	83	30	41
4.01-5.00	150	62	24	39
>5.00	357	154	62	79
Hydrocarbons, ppm				
0-100	1047	453	128	240
101-200	639	235	101	138
201-300	382	165	47	90
301-400	169	78	29	34
401-500	109	35	21	29
>500	309	137	53	70

[a] Includes Scott Air Force Base (Illinois), and Leavenworth and Kansas City, Kansas, data.

PASS/FAIL BY VEHICLE CHARACTERISTICS

Table 5 presents pass/fail data according to a variety of vehicle characteristics. The first tabulation is for model year. The model years in the tabulation correspond to the year intervals used in the New Jersey standards (see previously cited Table 3); the older the car, the more lenient the standard. For all locations, the highest percentage of failure (30 percent) was for the model years 1968 to 1969 and 1975 to 1979. Vehicles manufactured during 1967 and before had the lowest failure rate of 15.2 percent, but the standard for those model years is 2.8 times higher than the 1980 CO standard and 4.7 times higher than the 1980 HC standard. Although the percentages varied for the individual cities, the ranking stayed the same. An interesting observation is the percentage of 1980 vehicles failing. For all locations, the failure rate was 7 percent, or 1 in every 14 cars.

The second tabulation is by vehicle make. When more than 10 vehicles of a particular type were tested, passing percentages ranged from 57.5 (Cadillac) to 89 percent (Honda) in the data set for all locations; however, the data set is not large enough for the results to be statistically significant.

The third tabulation in Table 5 is by vehicle class. Light duty vehicles constituted 90.5 percent of all those tested, and the overall passing rate was 73.4 percent. Only half of the heavy-duty gas vehicles passed. All diesel-powered vehicles passed because the primary pollutant from diesel engines is particulate (not tested) rather than CO or HC. Only 41.1 percent of the motorcycles passed. The high rate of failure for motorcycles is due to their usual 2-cycle engine configuration. Some states have a adopted separate standards for motorcycles.

The remaining tabulations in Table 5 indicate pass/fail rates by number of cylinders, fuel type, and absence or presence of catalyst equipment. Two-cylinder engines (motorcycles) had the highest failure rate, whereas four-cylinder vehicles had the lowest. Approximately 40 percent of all the vehicles tested burned leaded fuel. Pass/fail rates differed very little between leaded and unleaded fuel usage or the absence or presence of catalyst equipment. All diesel-powered vehicles passed for the reason noted in the previous paragraph.

OTHER TABULATIONS

The data presented in Tables 2 through 5 are summary statistics. A significantly greater quantity of tabulations were

TABLE 5. VEHICLE PASS/FAIL DATA BY CHARACTERISTICS AND BY LOCATION

	All locations		Kansas City, Missouri area		St. Louis Missouri area		Wichita, Kansas area	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Model year								
1967 and older	72	13	25	3	7	3	23	3
1968 and 1969	59	16	26	4	7	3	12	5
1970 to 1974	435	188	164	76	56	26	109	43
1975 to 1979	1161	496	475	235	164	93	255	96
1980	200	15	86	9	20	0	50	5
Vehicle make								
American Motors	83	25	31	9	20	6	22	8
Audi	1	0	0	0	0	0	0	0
Austin	1	1	0	0	1	1	0	0
BMW	1	2	0	0	0	0	0	2
Buick	108	46	43	18	11	15	26	7
Cadillac	23	17	5	8	4	4	9	2
Capri	4	0	0	0	3	0	1	0
Chevrolet	415	141	161	68	55	26	106	28
Chrysler	40	16	17	7	7	3	6	5
Cushman	0	1	0	0	0	1	0	0
Datsun	83	20	35	10	6	0	20	4
Dodge	90	50	32	21	15	9	20	9
Fiat	7	5	3	2	0	1	0	0
Ford	371	154	169	74	44	21	79	27
GMC	17	4	6	0	2	0	2	2
Honda	39	5	22	1	3	1	8	2
International	12	4	9	4	2	0	1	0
Kawasaki	1	3	0	0	0	0	1	2
Lincoln	21	6	13	3	3	0	4	3
MG	4	2	3	1	0	0	1	0
Mazda	11	6	1	1	1	1	2	1
Mercedes Benz	9	0	2	0	0	0	3	0
Mercury	69	19	23	9	8	4	20	5

(continued)

TABLE 5 (continued).

	All locations		Kansas City, Missouri area		St. Louis, Missouri area		Wichita, Kansas area	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Oldsmobile	137	71	57	38	20	10	26	14
Opel	4	2	0	1	0	0	1	0
Peugot	1	0	0	0	0	0	1	0
Plymouth	82	45	41	23	6	5	23	10
Pontiac	97	45	37	18	19	12	23	10
Porsche	2	0	0	0	1	0	0	0
Renault	2	1	1	0	0	0	1	0
SAAB	1	0	1	0	0	0	0	0
Suburu	6	0	3	0	2	0	1	0
Toyota	76	16	33	3	9	3	11	8
Triumph	2	0	0	0	1	0	0	0
VW	86	16	24	8	10	2	22	2
Volvo	17	3	3	0	0	0	8	0
Yamaha	4	2	1	0	0	0	1	1
Vehicle class[b]								
LDV	1762	640	709	293	228	107	407	129
LDT1	113	60	41	23	13	11	33	16
LDT2	25	10	13	4	11	5	1	1
HDG	8	8	7	7	1	0	0	0
LDVD	11	0	3	0	0	0	6	0
HDD	1	0	1	0	0	0	0	0
Motorcycles	7	10	2	0	1	2	2	6
Number cylinders								
2	8	7	3	0	0	2	3	3
4	510	127	202	52	56	12	109	31
6	443	145	188	64	62	34	107	27
8	966	449	383	211	136	77	630	91

(continued)

TABLE 5 (continued).

	All locations		Kansas City, Missouri area		St. Louis, Missouri area		Wichita, Kansas area	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Fuel type								
Leaded	755	275	292	107	95	40	179	79
Unleaded	1160	433	400	220	159	85	264	73
Diesel	12	0	4	0	0	0	6	0
Catalytic converter								
Yes	1141	433	472	217	163	87	253	73
No	786	295	304	110	91	38	196	79

[a] Includes Scott Air Force Base (Illinois) and Kansas City, Kansas.
[b] LDV = Light-duty vehicles.
LDT1 = Light-duty gasoline-powered trucks, 0-6000 lb GVW.
LDT2 = Light-duty gasoline-powered trucks, 6000-8500 lb GVW.
HDG = Heavy-duty gasoline-powered trucks.
LDVD = Light-duty diesel-powered vehicles.
HDD = Heavy-duty diesel-powered vehicles.

made, as detailed in Section 3 (see Figure 2). Also, Appendix B contains the following tabulations.

For each model year class, and city:

1. Initial carbon monoxide values
2. Initial hydrocarbon values
3. Cross-tabulation of CO versus HC values (LDV)
4. Cross-tabulation of CO and HC values (all vehicle classes)

This results in 60 tabulations which give the basic data to determine pass/fail rates with any set of standards desired.

COMPARISON OF STUDY RESULTS WITH OTHER I/M STUDIES

Three other inspection/maintenance testing studies have been completed or are in process in the State of Missouri.

As part of the Federal Initiative, EPA Region VII performed testing during the summer of 1979. Of a total of 340 cars tested, 77 percent passed the New Jersey standards. This test result is not directly comparable, however, because during a portion of the testing, vehicles failing the initial test were adjusted and retested immediately and only the final emission rates were recorded. This procedure would, of course, produce higher passing rates.

In February 1980, the State of Missouri initiated a voluntary I/M program in the St. Louis area. This ongoing program is aimed at testing cars belonging to the general public. As of September 20, 1980, 34 percent of 5878 vehicles tested had failed the New Jersey Standards. This failure rate is within 1 percent of the failure rate produced by the St. Louis testing in this study.

The EPA has also distributed emission analyzers to Federal Motor Pools around Region VII. Federal fleet cars are periodically tested and maintenance is performed as required; however, no standardized records are kept on test level, repairs, or the effectiveness of repairs.

REFERENCES

1. Nie, H. H., et al. SPSS Statistical Package for the Social Sciences. Second Edition. McGraw-Hill, Inc., New York, New York. 1975.

APPENDIX A

MATERIALS DEVELOPED

United States
Environmental Protection
Agency

Region 7
324 East Eleventh St.
Kansas City, Mo. 64106

Air

May, 1980

EPA

Federal Initiative For Clean Air

Inspection and Maintenance

Inspection Record:

Date _____ ID No. _____

Your Car	Carbon Monoxide (CO)	Hydrocarbons (HC)
Passed		
Failed		

Voluntary (Demonstration)

Emission Standards	CO	HC
1975 and Newer	3.0%	300 ppm
1970 to 1974	5.0%	500 ppm
1968 and 1969	7.0%	700 ppm
1967 and Older	8.5%	1400 ppm

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Thank you for participating in this voluntary I/M program. This booklet will provide you with additional information and serve as a reference—

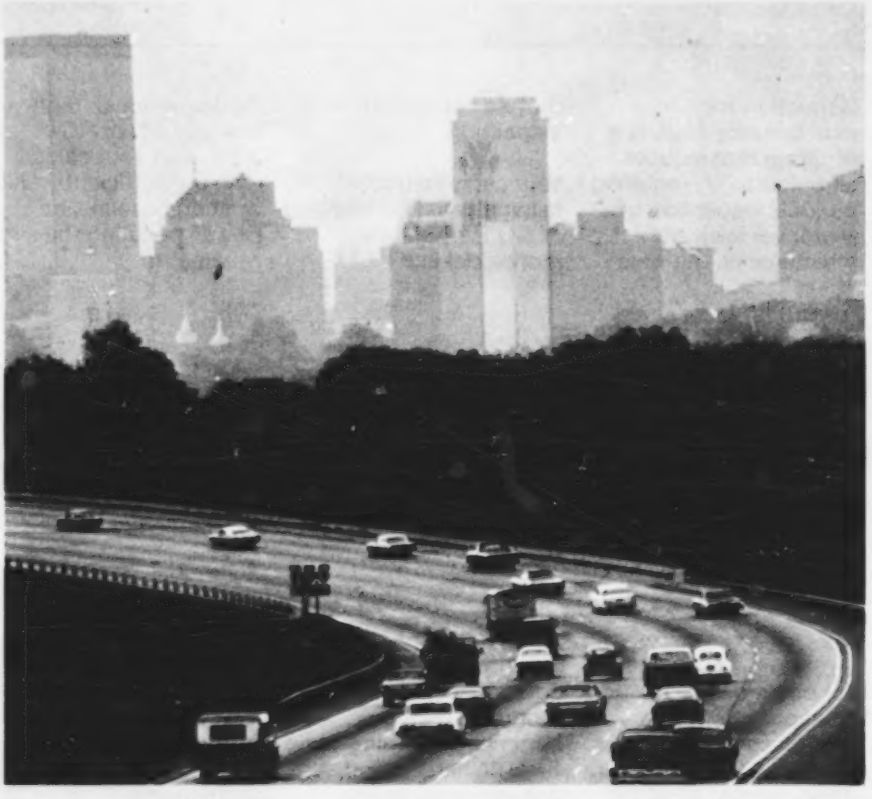
Read and keep it

This Federal Initiative was endorsed by the Federal Regional Council and is co-sponsored by the Federal Executive Board.

for further information:

US Environmental Protection Agency, Region VII
324 E. 11th St.
Kansas City, MO 64106

WHAT YOU SHOULD KNOW ABOUT INSPECTION AND MAINTENANCE



I/M Program

Your car plays a part in an urgent health problem—air pollution. In 1978, 104 out of 105 major urban areas in America violated one or more of the air quality standards that are related to health. Automobiles are a major cause of unhealthful air. Although your car has equipment that is designed to control pollution, the benefits of these controls are often not realized because the car is not properly maintained.

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WHAT I/M IS

Inspection and maintenance (I/M), is a program that reduces air pollution by requiring periodic inspection of motor vehicles and maintenance of those that do not pass the inspection.

Your car is inspected for tailpipe emission levels of CO (carbon monoxide) and HC (hydrocarbons). High levels of CO or HC mean that your car is running inefficiently and wasting gasoline, as well as polluting the air we breathe.

WHY I/M IS NEEDED

Air pollution from transportation continues to poison our air. In the Nation's urban areas, almost all of the carbon monoxide, about half of the hydrocarbons, and somewhat less than half of the nitrogen oxides (NO_x) come from mobile sources.

Carbon monoxide is a colorless, odorless, poisonous gas produced by the incomplete burning of fuels. When inhaled, this gas reduces the oxygen available to the brain and body cells and puts an extra burden on the heart and lungs.

Hydrocarbons and nitrogen oxides react together in the presence of sunlight to form photochemical oxidants (smog).

Ozone, the main constituent of photochemical smog, is a severe irritant to all mucous membranes. It has an especially bad effect on the respiratory system. On the following page is a summary of the health problems caused by these pollutants:

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HEALTH PROBLEMS

Health Problems

Carbon monoxide	Ozone
Dizziness	Coughing and wheezing
Headaches	Eye irritation
Blurred vision	More frequent asthmatic attacks
Slowed-down responses	
Fatigue	
Strain on cardiovascular system	

WHERE I/M IS NEEDED

The air we breathe contains excessive amounts of carbon monoxide and ozone. The amounts must be reduced in St. Louis, Kansas City, and Wichita before the standards of the Clean Air Act can be met.

REDUCTIONS NEEDED[1] IN AIR POLLUTION

	Ozone	Carbon monoxide
St. Louis	50%	35%
Kansas City	11%	a
Wichita	0%	44%

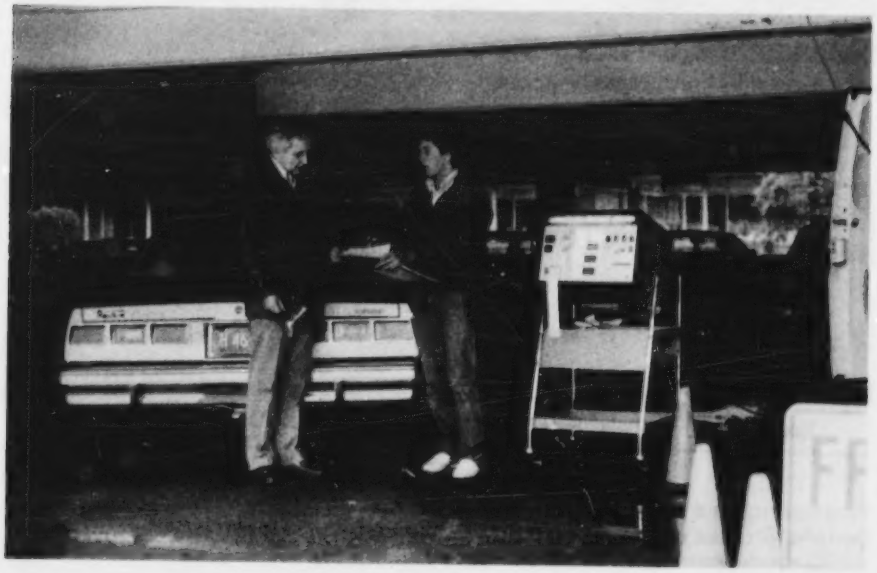
[1] Found in State Implementation Plan.
[a] Insufficient data to make projections.

In the Clean Air Act Amendments of 1977, Congress singled out I/M as a unique and cost-effective strategy for reducing pollution from automobiles. Urban areas that are unable to meet air quality standards by 1982 will be required to initiate I/M programs. Many states will begin these programs in the next few years.

HOW I/M WORKS

Inspections may be performed by a state or municipal authority at centralized inspection stations or by licensed service stations and garages. The testing process is the same in either case. When a motorist brings a car to the inspection site, an inspector inserts a probe into the tailpipe to measure emissions of hydrocarbons and carbon monoxide. If the emissions are within the prescribed standards, the motorist receives a certificate of conformance or a windshield sticker. With a mandatory inspection program, if the car fails the test, the motorist receives a notice of failure with a brief statement of probable causes. The motorist must then have the vehicle repaired so that it will meet the standards, and must return it for reinspection. The repairs are usually simple adjustments.

In contrast to a mandatory program, this Federal initiative for I/M is a voluntary program. If your car fails the test, repair of your car is voluntary.



BENEFITS OF I/M

I/M programs have been shown to reduce hydrocarbon and carbon monoxide emissions from automobiles.

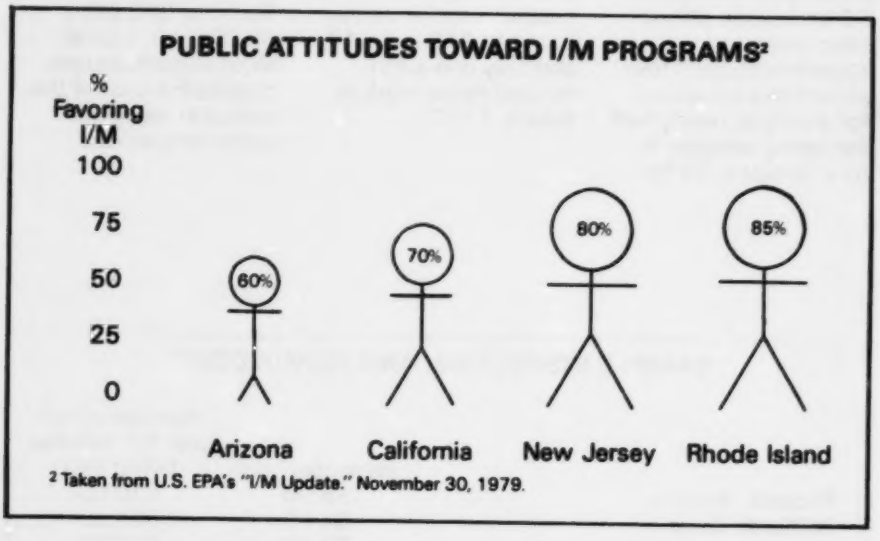
REDUCTIONS IN AUTOMOTIVE EMISSIONS FOLLOWING I/M PROGRAMS[1]

	Hydrocarbons	Carbon monoxide
Phoenix, Arizona	40%	25%
Portland, Oregon	47%	54%

[1] Taken from U.S. EPA's "Fact Sheet" May 17, 1979.

Fuel savings is a further benefit. Studies on pre-1975 model cars have shown that the fuel economy of cars failing an I/M test will probably improve following maintenance.

PUBLIC ATTITUDES



[2] Taken from U.S. EPA's "I/M Update." November 30, 1979.

Inspection and maintenance programs have worked well in areas where they have been introduced. Public opinion surveys in four states having I/M programs indicated that most people are in favor of the programs.

Reduced pollution means reduced suffering from heart, circulatory, and lung disorders. Less pollution means less aggravation of asthma, bronchitis, and allergies. Cars that go through an annual I/M program burn less fuel, need fewer repairs, and last longer.

WHAT I/M COSTS

Cars are most likely to fail an inspection because of excessive CO emissions. Minor, inexpensive adjustments can often correct this condition. For example, nearly half the failing vehicles in New Jersey in 1976-1977 required only a carburetor adjustment at $10 or less, one-third needed a minor tuneup between $13 and $40, and only one-sixth needed major work at $30 to $100.

Inspection fees for I/M programs now in operation range from $2.50 to $12.50; a $5.00 fee is typical. Most inspection fees include the cost of the annual state vehicle safety inspection.

SAMPLE INSPECTION AND REPAIR COST[1]

	Inspection fee	Average repair cost for vehicles failing test
Phoenix, Arizona	$5.00	$30.00
Portland, Oregon	$5.00	$29.00
New Jersey (statewide)	$2.50	$19.00

[1]Taken from U.S. EPA's "Fact Sheet" May 17, 1979

TAMPERING AND FUEL SWITCHING

Allowing someone to tamper (remove or make ineffective) with the air pollution control devices on your car is **against Federal law.**[3] It is also against Federal law to put leaded fuel into a car requiring unleaded.[4] Violators are subject to a fine of up to $10,000 per violation.

Besides the threat of federal prosecution, the main reason for not tampering or switching fuels is that, in most cases, removing pollution control device, does not improve your car's gas mileage and performance. In many cases it may make them worse. The one sure result from tampering or fuel switching is that it will increase your car's emissions and add to air pollution.

[3]Taken from U.S. EPA's "Do You Own A Car?" January, 1978.

[4]Taken from U.S. EPA's "Unleaded Gas . . . The Way To Go" September, 1978.

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IF YOUR CAR FAILS THE TEST . . .

Your car failed because it was not maintained to assure CLEAN AIR. If you work on your car, you may be able to correct the problem by making the adjustment yourself. Of course, you might need the help of a professional to tackle the more complex problems.

The information on pages 12, 13, 14, and 15 tells you what needs to be done and how to do it. **Read it over before you jump in.** Whoever works on your car has the responsibility for the air you breathe.

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CAUSES OF FAILURE

The following chart shows probable causes for failing either the CO or the HC emissions test. Use this chart to aid in the diagnosis and repair of your automobile. If your car had excessive emissions of both CO and HC, perform repairs to correct the CO problem first. Consult the Glossary at the end of this booklet for definitions of some of the terms used.

PROBABLE CAUSES OF FAILURE[5]

Excessive CO emissions

1. Air filter
2. Choke
3. Thermostatic air filter housing
4. PCV valve
5. Heat riser
6. Idle air/fuel

Excessive HC emissions

1. Air pump
2. Ignition system
3. Dwell timing
4. Air/fuel ratio
   - Vacuum system
   - EGR, PCV valves
   - Idle air/fuel
5. Engine mechanical
   - Valves
   - Rings
   - Gaskets

[5] Taken from U.S. EPA's "So You Failed the Emission Test" Undated

STEPS TO FOLLOW TO REDUCE CO EMISSIONS

	Check
1. Air filter	Remove air filter with the housing in place. Hold filter up to a bright light. If light shines through the filter, it is still good.
2. Choke	With engine warmed up and at normal idle, the choke plate should be open and move freely with light finger pressure.
3. Thermostatic Air filter housing	With engine idling and air filter housing in place, stick finger into cold air intake snorkel; flap should be folded back.
4. PCV valve	Remove PCV valve from grommet on valve cover, leaving hose connected. While engine is idling, feel for strong vacuum at PCV valve opening. Strong vacuum indicates that valve and hose are not restricted.
5. Heat riser	CAUTION: HOT. Use a screwdriver or pliers to move heat riser balance arm. It should move freely.
6. Idle air/fuel	If limiter caps are in place, idle air/fuel mixture is close to being correctly adjusted.

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STEPS TO FOLLOW TO REDUCE CO EMISSIONS

Service

Replace filter or service as necessary.

Binding or sticking to the carburetor body can be corrected by bending the choke plate. Choke adjustments should be made to manufacturer's specifications.
PROFESSIONAL REPAIR IS RECOMMENDED.

If cold air flap is blocking opening, repair binding problem, misrouted vacuum lines, or faulty temperature sensor. PROFESSIONAL REPAIR IS RECOMMENDED.

If only slight or no vacuum is felt, remove PCV valve from hose and feel for strong vacuum at hose. If hose vacuum is strong, replace PCV valve and clean PCV filter in air filter housing. If hose vacuum is weak, clean or replace cracked, broken, or collapsed hose. Retest.

Apply carburetor spray (CAUTION: FLAMMABLE) and graphite lube; work until arm moves freely.

While engine is off, remove air filter housing and plug the vacuum lines. If car has a multiple-barrel carburetor, turn mixture screws clockwise to seal lightly. Turn both counterclockwise three (3) turns. BOTH SCREWS MUST ALWAYS BE ADJUSTED THE SAME NUMBER OF TURNS IN OR OUT.

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STEPS TO FOLLOW TO REDUCE HC EMISSIONS

	Check
1. Air pump	While engine is off, check belt tension and pulley connection if the car is so equipped. Check air pump hose for wear, cracking, or loose connections.
2. Ignition system	In nonelectronic ignition systems, with engine off, check points for burning or pitting. Perform the following cylinder balance test: (1) Record initial idle RPM, then turn car off. (2) Carefully remove one plug wire, restart engine, and record idle RPM. (3) Stop engine and reconnect plug wire. Repeat for each cylinder (CAUTION: Catalyst-equipped cars should not idle for prolonged periods during balance test). If the balance test shows a similar RPM difference for each cylinder, engine is operating properly (each cylinder is contributing equal power to the engine). A balance test showing a small or no drop in RPM indicates an ignition problem, an engine mechanical problem, or misrouted plug wires. Use a compression test to see if there any any engine mechanical problems (rings, valves, gaskets). Check spark plugs for evidence of gross defects.
3. Dwell timing	Use a dwell meter and a timing light.
4. Air/fuel ratio	With the engine turned off, check vacuum and PCV hoses, connections, and accessories for breaks, cracking, and loose connections. Remove PCV valve from grommet on valve cover. Leave connected to PCV hose. Start engine, and cover end of PCV valve. If engine RPM increases, PCV is allowing too much air into system.
5. Engine mechanical	The balance test and compression test results will show whether a problem exists with rings, valves, or head gaskets.

If these steps do not reduce the HC emissions, and if a professional mechanic finds no engine mechanical or ignition problems, the likely cause is one of the following:

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STEPS TO FOLLOW TO REDUCE HC EMISSIONS

Service

As necessary. PROFESSIONAL REPAIR IS RECOMMENDED.

Check firing order and wire problems. Replace and gap spark plugs if necessary. Simple ignition problems can be solved by making sure connections are tight and free from corrosion. If any cylinders are serviced or repaired, perform the balance test again for them. PROFESSIONAL REPAIR IS RECOMMENDED for more complex ignition or engine mechanical problems.

In nonelectronic ignition systems, first adjust dwell angle (point gap) to manufacturer's specifications. Next, adjust the initial timing, using manufacturer's procedure (consult the engine decal or specification sheet). The correct initial timing is very important for passing an emissions test.

If necessary: (1) replace vacuum hose(s). (2) Tighten carburetor and intake manifold holddown bolts to manufacturer's specified torque. (3) Replace PCV hose or valve (use proper type for engine). (4) If EGR valve requires service, remove the valve, clean stem and orifices and reinstall with new gasket. (5) Adjust carburetor as outlined in steps from reducing CO emissions. PROFESSIONAL REPAIR IS RECOMMENDED.

PROFESSIONAL REPAIR IS RECOMMENDED.

Leaking EGR valve
Leaking intake manifold
Leaking carburetor gasket
Leaking vacuum accessory/diaphragm or misrouted vacuum line.

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GLOSSARY

air filter: Filters air entering the carburetor. If restricted, too little air mixes with fuel in the carburetor. Result: rich mixture, excessive CO, poor combustion, poor fuel economy.

air/fuel mixture screws: Controls air/fuel mixture at idle and low speeds. Located at base of carburetor. One screw on single-barrel carburetor, two screws on multiple-barrel carburetor. Improper adjustment can cause either a rich or a lean mixture. Result: rich mixture, excessive CO; lean mixture, excessive HC, poor combustion, poor fuel economy.

air pump: Provides air to the exhaust manifold for more complete oxidation of HC and CO. Malfunctions of the pump, belt/pully connection, or piping can cause defective operation. Result: excessive HC.

choke: Provides a rich mixture for starting by restricting air-flow into carburetor. Binding of the choke plate or external linkages can cause choke to remain closed after warmup. Result: rich mixture, excessive CO, poor combustion, poor fuel economy.

converter: Oxidizes HC and CO to water and carbon dioxide. Located between the exhaust manifold and muffler. Use of leaded fuel can reduce converter efficiency. A mixture of leaded and unleaded fuels can cause overheating, which may melt the catalyst bed and cause exhaust backpressure. Results: excessive HC and CO, possible backpressure problem that will reduce fuel economy.

EGR valve: Recirculates exhaust gases into the intake manifold to reduce nitrogen oxixde (NO_x) emissions. Located near the carburetor base on the intake manifold. Deposits can cause EGR (exhaust gas recirculation) valve to remain open at all times. Result: lean misfire, excessive HC, poor combustion, poor fuel economy.

engine mechanical integrity: Assures proper engine operation. Includes valves, rings, gaskets, etc. Wear or failure may reduce engine performance. Result: excessive HC, poor fuel economy.

engine vacuum: Controls engine and accessory operation. Includes vacuum lines, intake manifold, carburetor, distributor advance unit, and vacuum-operated accessories. Air leaks in those components may significantly change the air/fuel ratio. Result: lean mixture, excessive HC, poor combustion, poor fuel economy.

heat riser: Circulates exhaust through special passages of the intake manifold to assist warmup. This valve is located between exhaust manifold and exhaust pipe. If stuck in the cold position heating will occur after warmup. Result: poor combustion, poor fuel economy.

ignition system: Provides spark at the right time and of the proper duration for good combustion. Improper timing, poor spark, or faulty components can cause emission and performance problems. Result: faulty combustion, excessive HC, poor fuel economy.

PCV valve: Prevents crankcase vapors from polluting the air by drawing them into the intake manifold. An incorrect PCV (positive crankcase ventilation) valve may lessen intake manifold vacuum. A restricted PCV system may cause improperly high intake manifold vacuum. Result: lean mixture, excessive HC; rich mixture, excessive CO, poor combustion, poor fuel economy.

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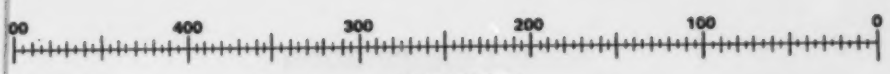
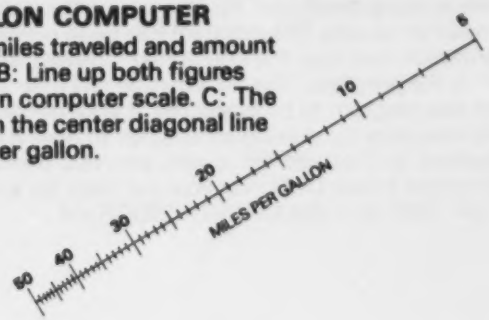
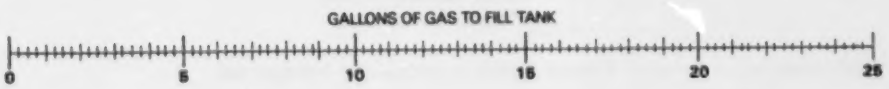


MILES PER GALLON COMPUTER

A: Determine total miles traveled and amount of gas to refill tank. B: Line up both figures with straight edge on computer scale. C: The intersecting point on the center diagonal line will give you miles per gallon.





METRIC CONVERSION TABLE

LENGTH		
	1 inch	**2.5** centimeters
	1 foot	**0.3** meters
	1 yard	**0.9** meters
	1 mile	**1.6** kilometers
WEIGHT		
	1 ounce	**28.4** grams
	1 pound	**453.6** grams
VOLUME		
	1 quart	**1.1** liters
	1 gallon	**3.8** liters

Retest Information

The I/M program is being developed for you and all the people around you in an attempt to improve air quality. The program has been proved effective in other cities. The information that you, the concerned motorist, supply is the most important input in the program. This information will then allow the effectiveness of the program to be evaluated. If your car does fail the emission test, please help everyone by making an attempt to have it repaired. If you have your vehicle repaired, or if you do the repairs yourself, please complete the requested information below and bring your car back for a retest. PLEASE REMEMBER THAT THIS IS A VOLUNTARY PROGRAM.

Repair Information
(Please Complete)

Explanation of repairs: Please check appropriate categories.

Carb adj.		PCV		EGR	
Air filter		Timing		Air pump	
Choke		Spark plugs		Other	

Cost:
Facility name:
Mileage:

Idle Reinspection Data

Your car	HC	CO
Passed		
Failed		

FREE

AUTO EMISSIONS TESTING

IS YOUR CAR CLEAN?

Vehicles Are The Major Source of Air Pollution

I/M Improves Fuel Economy

PLEASE HAVE YOUR CAR CHECKED

DECAL FOR PASSING AUTOS

Federal Facility—

Dates—

Times—

Contact—

Location of Vehicle Emissions Testing Station—

SPONSORED BY EPA REGION VII

EPA REGION VII

YOUR CAR AND CLEAN AIR: A VOLUNTARY DEMONSTRATION OF THE AUTOMOBILE INSPECTION AND MAINTENANCE PROGRAM

THE PROGRAM

The purpose of this voluntary program is to show you how regular inspection and maintenance can benefit you and your car. Automobiles are responsible for about 95 percent of the carbon monoxide and about half of the smog (photochemical oxidants) in the air we breathe. Inspection and maintenance (I/M) programs can improve air quality by reducing automobile emissions.

Cleaner air is important for our health. When carbon monoxide and smog in the air exceed safe levels, they can cause severe health problems among children, elderly persons, and those with respiratory or heart ailments. These levels are exceeded in St. Louis, Kansas City, and Wichita at various times during the year.

THE BENEFITS

Cleaner air—Studies show that pollution from vehicles is substantially reduced by good maintenance. When catalytic-type vehicles that failed inspection were repaired, carbon monoxide emissions were reduced 54 percent and hydrocarbon emissions were reduced 47 percent. (Hydrocarbons join with other chemicals to form smog.)

Better fuel economy—Good vehicle maintenance can improve fuel economy in current technology models.

Extended engine life—Engine or component life may be extended due to proper maintenance.

YOUR OBLIGATION

This is a free, voluntary program sponsored by the U.S. Environmental Protection Agency. If you pass the I/M test, you will receive a decal to display on your windshield if you choose to do so. If you do not pass, you are under no obligation to repair your vehicle. Most repairs, however, are just minor, inexpensive adjustments.

If you decide to repair the car yourself, you may consult the brief listing of problems and repair procedures included in the I/M booklet that is distributed during the test. You can have your car retested as many times as you want. The testing station will be near your workplace at various times throughout May, June, July and August. Posters giving the dates, location, and testing hours will be displayed at all main entrances to our building a few days before testing begins.

APPENDIX B

SELECTED DATA SUMMARIES

CROSSTABULATION OF COCODE CODED INITIAL CARBON MONOXIDE VALUES #8 BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM

COCODE	COUNT / ROW PCT / COL PCT / TOT PCT	HCCODE 10-100PPM 100.	101-200 PPM 200.	201-300 PPM 300.	301-400 PPM 400.	>500PPM 600.	ROW TOTAL
0-1#8	1.	4	1	0	0	0	5
		80.0	20.0	0	0	0	17.9
		66.7	16.7	0	0	0	
		14.3	3.6	0	0	0	
1.01-2#8	2.	2	4	0	1	3	10
		20.0	40.0	0	10.0	30.0	35.7
		33.3	66.7	0	20.0	33.3	
		7.1	14.3	0	3.6	10.7	
2.01-3#8	3.	0	0	1	0	0	1
		0	0	100.0	0	0	3.6
		0	0	50.0	0	0	
		0	0	3.6	0	0	
3.01-4#8	4.	0	0	0	1	0	1
		0	0	0	100.0	0	3.6
		0	0	0	20.0	0	
		0	0	0	3.6	0	
4.01-5#8	5.	0	1	0	1	1	3
		0	33.3	0	33.3	33.3	10.7
		0	16.7	0	20.0	11.1	
		0	3.6	0	3.6	3.6	
>5#8	6.	0	0	1	2	5	8
		0	0	12.5	25.0	62.5	28.6
		0	0	50.0	40.0	55.6	
		0	0	3.6	7.1	17.9	
	COLUMN TOTAL	6	6	2	5	9	28
		21.4	21.4	7.1	17.9	32.1	100.0

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I/M DATA-KANSAS CITY- FOR 1967 AND OLDER VEHICLES
FREQUENCY OF OCCURRENCE OF CODED CARBON MONOXIDE DATA

C01 INITIAL CARBON MONOXIDE READINGS PERCENT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0-1%B	1.	5	17.9	17.9	17.9
1.01-2%B	2.	10	35.7	35.7	53.6
2.01-3%B	3.	1	3.6	3.6	57.1
3.01-4%B	4.	1	3.6	3.6	60.7
4.01-5%B	5.	3	10.7	10.7	71.4
5.01-6%B	6.	4	14.3	14.3	85.7
7.01-8%B	8.	2	7.1	7.1	92.9
8.01-9%B	9.	2	7.1	7.1	100.0
	TOTAL	28	100.0	100.0	

VALID CASES 28 MISSING CASES 0

I/M DATA-KANSAS CITY- FOR 1967 AND OLDER VEHICLES
FREQUENCY OF OCCURRENCE OF CODED HYDROCARBON DATA

HC1 INITIAL HYDROCARBON READING PPM

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0-100PPM	100.	6	21.4	21.4	21.4
101-200 PPM	200.	6	21.4	21.4	42.9
201-300 PPM	300.	2	7.1	7.1	50.0
301-400 PPM	400.	5	17.9	17.9	67.9
501-600 PPM	600.	2	7.1	7.1	75.0
601-700 PPM	700.	1	3.6	3.6	78.6
801-900 PPM	900.	1	3.6	3.6	82.1
901PPM- 1000PPM	1000.	1	3.6	3.6	85.7
1001PPM-1100PPM	1100.	1	3.6	3.6	89.3
1201PPM-1300PPM	1300.	1	3.6	3.6	92.9
1301PPM-1400PPM	1400.	1	3.6	3.6	96.4
>2000PPM	2100.	1	3.6	3.6	100.0
	TOTAL	28	100.0	100.0	

VALID CASES 28 MISSING CASES 0

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES PPM BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES %B BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

CROSSTABULATION OF COCODE CODED INITIAL CARBON MONOXIDE VALUES #R BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM

COCODE		HCCODE 10-100PPM	101-200 PPM	201-300 PPM	301-400 PPM	401-500 PPM	>500PPM	ROW TOTAL
	COUNT	100.	200.	300.	400.	500.	600.	
0-1#R	1.	228	69	30	10	8	34	379
	ROW PCT	60.2	18.2	7.9	2.6	2.1	9.0	53.4
	COL PCT	81.7	43.7	27.3	19.6	27.6	41.0	
	TOT PCT	32.1	9.7	4.2	1.4	1.1	4.8	
1.01-2#R	2.	41	30	18	4	0	8	101
	ROW PCT	40.6	29.7	17.8	4.0	0	7.9	14.2
	COL PCT	14.7	19.0	16.4	7.8	0	9.6	
	TOT PCT	5.8	4.2	2.5	.6	0	1.1	
2.01-3#R	3.	9	26	15	7	0	8	65
	ROW PCT	13.8	40.0	23.1	10.8	0	12.3	9.2
	COL PCT	3.2	16.5	13.6	13.7	0	9.6	
	TOT PCT	1.3	3.7	2.1	1.0	0	1.1	
3.01-4#R	4.	0	14	19	6	6	2	47
	ROW PCT	0	29.8	40.4	12.8	12.8	4.3	6.6
	COL PCT	0	8.9	17.3	11.8	20.7	2.4	
	TOT PCT	0	2.0	2.7	.8	.8	.3	
4.01-5#R	5.	1	9	11	2	5	6	34
	ROW PCT	2.9	26.5	32.4	5.9	14.7	17.6	4.8
	COL PCT	.4	5.7	10.0	3.9	17.2	7.2	
	TOT PCT	.1	1.3	1.5	.3	.7	.8	
>5#R	6.	0	10	17	22	10	25	84
	ROW PCT	0	11.9	20.2	26.2	11.9	29.8	11.8
	COL PCT	0	6.3	15.5	43.1	34.5	30.1	
	TOT PCT	0	1.4	2.4	3.1	1.4	3.5	
COLUMN TOTAL		279	158	110	51	29	83	710
		39.3	22.3	15.5	7.2	4.1	11.7	100.0

66<

* C R O S S T A B U L A T I O N O F *
COCODE CODED INITIAL CARBON MONOXIDE VALUES #B BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* *

COCODE	COUNT / ROW PCT / COL PCT / TOT PCT	HCCODE 0-100PPM 100.	101-200 PPM 200.	201-300 PPM 300.	301-400 PPM 400.	401-500 PPM 500.	>500PPM 600.	ROW TOTAL
0-1#B	1.	75	5	4	0	1	1	86
		87.2	5.8	4.7	0	1.2	1.2	90.5
		98.7	71.4	66.7	0	100.0	33.3	
		78.9	5.3	4.2	0	1.1	1.1	
1.01-2#B	2.	1	1	0	1	0	0	3
		33.3	33.3	0	33.3	0	0	3.2
		1.3	14.3	0	50.0	0	0	
		1.1	1.1	0	1.1	0	0	
2.01-3#B	3.	0	0	0	1	0	0	1
		0	0	0	100.0	0	0	1.1
		0	0	0	50.0	0	0	
		0	0	0	1.1	0	0	
3.01-4#B	4.	0	1	1	0	0	0	2
		0	50.0	50.0	0	0	0	2.1
		0	14.3	16.7	0	0	0	
		0	1.1	1.1	0	0	0	
4.01-5#B	5.	0	0	1	0	0	0	1
		0	0	100.0	0	0	0	1.1
		0	0	16.7	0	0	0	
		0	0	1.1	0	0	0	
>5#B	6.	0	0	0	0	0	2	2
		0	0	0	0	0	100.0	2.1
		0	0	0	0	0	66.7	
		0	0	0	0	0	2.1	
COLUMN TOTAL		76	7	6	2	1	3	95
		80.0	7.4	6.3	2.1	1.1	3.2	100.0

I/M DATA-WICHITA-FOR 1967 AND OLDER VEHICLES
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
FILE IMSUMRY (CREATION DATE = 10/22/80.)

10/22/80. 20.08.06. PAGE 5

* C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
COCODE CODED INITIAL CARBON MONOXIDE VALUES #B BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* *
PAGE 1 OF 1

COCODE	COUNT / ROW PCT / COL PCT / TOT PCT	HCCODE 0-100PPM 100.	101-200 PPM 200.	201-300 PPM 300.	301-400 PPM 400.	>500PPM 600.	ROW TOTAL
0-1#B	1.	3	0	0	0	1	4
		75.0	0	0	0	25.0	15.4
		100.0	0	0	0	9.1	
		11.5	0	0	0	3.8	
1.01-2#B	2.	0	2	0	0	1	3
		0	66.7	0	0	33.3	11.5
		0	50.0	0	0	9.1	
		0	7.7	0	0	3.8	
2.01-3#B	3.	0	1	2	0	2	5
		0	20.0	40.0	0	40.0	19.2
		0	25.0	40.0	0	18.2	
		0	3.8	7.7	0	7.7	
3.01-4#B	4.	0	0	0	1	0	1
		0	0	0	100.0	0	3.8
		0	0	0	33.3	0	
		0	0	0	3.8	0	
4.01-5#B	5.	0	1	2	1	1	5
		0	20.0	40.0	20.0	20.0	19.2
		0	25.0	40.0	33.3	9.1	
		0	3.8	7.7	3.8	3.8	
>5#B	6.	0	0	1	1	6	8
		0	0	12.5	12.5	75.0	30.8
		0	0	20.0	33.3	54.5	
		0	0	3.8	3.8	23.1	
	COLUMN TOTAL	3	4	5	3	11	26
		11.5	15.4	19.2	11.5	42.3	100.0

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES %B BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

I/M DATA-WICHITA-FOR 1970-1974 VEHICLES
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
FILE IMSUMRY (CREATION DATE = 10/22/80.)

10/22/80. 20.08.03. PAGE 5

* C R O S S T A B U L A T I O N O F *
CDCODE CODED INITIAL CARBON MONOXIDE VALUES #R BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES PPM BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

* C R O S S T A B U L A T I O N O F *
COCODE CODED INITIAL CARBON MONOXIDE VALUES %R BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

I/M DATA-ST LOUIS-FOR 1967 AND OLDER VEHICLES 10/22/80. 20.06.28. PAGE 5
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
FILE INSUMRY (CREATION DATE = 10/22/80.)

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES GR BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM PAGE 1 OF 1
* *

		HCCODE			
	COUNT / ROW PCT / COL PCT / TOT PCT	101-200 PPM	301-400 PPM	>500PPM	ROW TOTAL
		200.	400.	600.	
COCODE					
	1.	0	0	1	1
0-1GR		0	0	100.0	10.0
		0	0	14.3	
		0	0	10.0	
	2.	0	0	1	1
1.01-2GR		0	0	100.0	10.0
		0	0	14.3	
		0	0	10.0	
	4.	1	0	1	2
3.01-4GR		50.0	0	50.0	20.0
		100.0	0	14.3	
		10.0	0	10.0	
	6.	0	2	4	6
>5GR		0	33.3	66.7	60.0
		0	100.0	57.1	
		0	20.0	40.0	
COLUMN TOTAL		1	2	7	10
		10.0	20.0	70.0	100.0

I/M DATA-ST LOUIS-FOR 1968 AND 1969 VEHICLES
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
FILE DSUMRY (CREATION DATE = 10/22/80.)

10/22/80. 20.06.49. PAGE 5

* CROSSTABULATION OF *
COCODE CODED INITIAL CARBON MONOXIDE VALUES (%) BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

CROSSTABULATION OF COCODE CODED INITIAL CARBON MONOXIDE VALUES GM BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM

COCODE	COUNT / ROW PCT / COL PCT / TOT PCT	HCCODE 0-100PPM 100.	101-200 PPM 200.	201-300 PPM 300.	301-400 PPM 400.	401-500 PPM 500.	>500PPM 600.	ROW TOTAL
0-1GM	1.	11	10	1	0	1	0	23
		47.8	43.5	4.3	0	4.3	0	28.0
		55.0	38.5	9.1	0	16.7	0	
		13.4	12.2	1.2	0	1.2	0	
1.01-2GM	2.	4	2	0	1	1	3	11
		36.4	18.2	0	9.1	9.1	27.3	13.4
		20.0	7.7	0	12.5	16.7	27.3	
		4.9	2.4	0	1.2	1.2	3.7	
2.01-3GM	3.	4	4	1	0	0	1	10
		40.0	40.0	10.0	0	0	10.0	12.2
		20.0	15.4	9.1	0	0	9.1	
		4.9	4.9	1.2	0	0	1.2	
3.01-4GM	4.	1	3	1	2	0	1	8
		12.5	37.5	12.5	25.0	0	12.5	9.8
		5.0	11.5	9.1	25.0	0	9.1	
		1.2	3.7	1.2	2.4	0	1.2	
4.01-5GM	5.	0	5	4	0	0	1	10
		0	50.0	40.0	0	0	10.0	12.2
		0	19.2	36.4	0	0	9.1	
		0	6.1	4.9	0	0	1.2	
>5GM	6.	0	2	4	5	4	[illegible]	[illegible]
		0	10.0	20.0	25.0	20.0	25.0	24.4
		0	7.7	36.4	62.5	66.7	45.5	
		0	2.4	4.9	6.1	4.9	6.1	
	COLUMN TOTAL	20 24.4	26 31.7	11 13.4	8 9.8	6 7.3	11 13.4	82 100.0

I/M DATA-ST LOUIS-FOR 1975-1979 VEHICLES 10/22/80. 20.05.59. PAGE 5
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
FILE IMSUMRY (CREATION DATE = 10/22/80.)

* C R O S S T A B U L A T I O N O F *
COCODE CODED INITIAL CARBON MONOXIDE VALUES GM BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* PAGE 1 OF 1

COCODE	COUNT / ROW PCT / COL PCT / TOT PCT	HCCODE 0-100PPM 100.	101-200 PPM 200.	201-300 PPM 300.	301-400 PPM 400.	401-500 PPM 500.	>500PPM 600.	ROW TOTAL
0-1GM	1.	78	27	13	3	2	14	137
		56.9	19.7	9.5	2.2	1.5	10.2	53.3
		86.7	39.1	38.2	16.7	16.7	41.2	
		30.4	10.5	5.1	1.2	.8	5.4	
1.01-2GM	2.	9	14	3	1	1	1	29
		31.0	48.3	10.3	3.4	3.4	3.4	11.3
		10.0	20.3	8.8	5.6	8.3	2.9	
		3.5	5.4	1.2	.4	.4	.4	
2.01-3GM	3.	3	15	2	2	1	3	26
		11.5	57.7	7.7	7.7	3.8	11.5	10.1
		3.3	21.7	5.9	11.1	8.3	8.8	
		1.2	5.8	.8	.8	.4	1.2	
3.01-4GM	4.	0	7	7	4	0	1	19
		0	36.8	36.8	21.1	0	5.3	7.4
		0	10.1	20.6	22.2	0	2.9	
		0	2.7	2.7	1.6	0	.4	
4.01-5GM	5.	0	3	4	1	2	4	14
		0	21.4	28.6	7.1	14.3	28.6	5.4
		0	4.3	11.8	5.6	16.7	11.8	
		0	1.2	1.6	.4	.8	1.6	
>5GM	6.	0	3	5	7	6	11	32
		0	9.4	15.6	21.9	18.8	34.4	12.5
		0	4.3	14.7	38.9	50.0	32.4	
		0	1.2	1.9	2.7	2.3	4.3	
	COLUMN TOTAL	90	69	34	18	12	34	257
		35.0	26.8	13.2	7.0	4.7	13.2	100.0

I/M DATA-ST LOUIS-FOR 1980 VEHICLES
DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS 10/22/80. 20.05.50. PAGE 5
FILE IMSUMRY (CREATION DATE = 10/22/80.)

* C R O S S T A B U L A T I O N O F *
COCODE CODED INITIAL CARBON MONOXIDE VALUES GM BY HCCODE CODED INITIAL HYDROCARBON VALUES PPM
* * * * * * * * * * * * * * * * * * * \

APPENDIX C

EXAMPLE SPSS INPUT STATEMENTS

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TABLE C-1. EXAMPLE OF CROSS-TABULATION SPSS PROGRAM STATEMENTS

```
00240 RUN NAME        I/M DATA-ST LOUIS-FOR 1967 AND OLDER VEHICLES
00250 COMMENT         RUN NAME IDENTIFIES THE CURRENT RUN. THIS NAME IS PRINTED
00260                 AT THE TOP OF EVERY PAGE. IT MAY BE COMPOSED OF ANY VALID
00270                 CHARACTER. MAXIMUM LENGTH IS 64 CHARACTERS.
00280 FILE NAME       INSUMRY
00290 COMMENT         FILE NAME IDENTIFIES THE SYSTEM FILE. 8 CHARACTERS LONG.
00300                 MUST START WITH AN ALPHANETIC CHARACTER.
00310 VARIABLE LIST   CITIES,FACILTY,MODELYR,VEHMAKE,VEHCLS,NUMCYL,FUELTYP,
00320                 CATALST,HC1,CO1
00330 COMMENT         THESE ARE THE VARIABLE NAMES IN THE ORDER THAT THEY OCCUR
00340                 ON THE INPUT CARDS
00350 INPUT MEDIUM    DISK
00360 N OF CASES      UNKNOWN
00370 INPUT FORMAT    FIXED(F1.0,F2.0,2?X.F2.0,1X,A3,F1.0,3X,F1.0,A1,A1,F4.0,1X,
00380                 F4.2)
00390 COMMENT         FOR THESE RUNS ALL DATA AND INPUTS ARE STORED ON DISK.
00400                 BY SPECIFYING N OF CASES IS UNKNOWN SPSS WILL DETERMINE
00410                 THE LENGTH OF THE INPUT DATA FILE
00420 VALUE LABELS    CITIES (1)KANSAS-CITY (2)WICHITA (3)ST-LOUIS/
00430                 VEHMAKE ('AME')AMERICAN-MOTORS ('BUI')BUICK ('CAD')CADILLAC
00440                 ('CHE')CHEVROLET ('CHR')CHRYSLER ('DOD')DODGE ('FOR')FORD
00450                 ('LIN')LINCOLN ('MER')MERCURY ('OLD')OLDSMOBILE
00460                 ('PON')PONTIAC ('GMC')GENERAL MOTORS ('INT')INTERNATIONAL
00470                 ('AUD')AUDI ('AUS')AUSTIN ('BMW')BMW ('CAP')CAPRI
00480                 ('FIA')FIAT ('HON')HONDA ('MAZ')MAZDA ('MER')MERCEDES BENZ
00490                 ('OPE')OPEL ('POR')PORSCHE ('REN')RENAULT ('SAA')SAAB
00500                 ('TOY')TOYOTA ('TRI')TRIUMPH ('VLK')VOLKSWAGEN ('VLV')VOLVO
00510                 ('PLY')PLYMOUTH ('DAT')DATSUN ('MG')MG ('SUB')SUBARU
00520                 ('KAW')KAWASAKI ('PEU')PEUGOT ('YAM')YAMAHA ('CUS')CUSHMAN,
00530                 VEHCLS (1)LDV (2)LDT1 (3)LDT2 (4)HDG (5)LDVD (6)HDD (7)ML/
00540                 FUELTYP ('L')LEADED ('U')UNLEADED ('D')DIESEL/
00550                 CATALST ('Y')WITH CATALST ('N')WITHOUT CATALST/
00560                 HC1 (100)0-100PPM (200)101-200 PPM (300)201-300 PPM
00570                 (400)301-400 PPM (500)401-500 PPM (600)501-600 PPM
00580                 (700)601-700 PPM (800)701-800 PPM (900)801-900 PPM
00590                 (1000)901PPM- 1000PPM (1100)1001PPM-1100PPM
00600                 (1200)1101PPM-1200PPM (1300)1201PPM-1300PPM
00610                 (1400)1301PPM-1400PPM (1500)1401PPM-1500PPM
00620                 (1600)1501PPM-1600PPM (1700)1601PPM-1700PPM
00630                 (1800)1701PPM-1800PPM (1900)1801PPM-1900PPM
00640                 (2000)1901PPM-2000PPM (2100)>2000PPM/
00650                 CO1 (1)0-1% (2)1.01-2%(3)2.01-3% (4)3.01-4%
00660                 (5)4.01-5% (6)5.01-6% (7)6.01-7% (8)7.01-8% (9)8.01-9%
00670                 (10)>9%/
00680 COMMENT         VALUE LABELS SPELL OUT INPUT DATA CODES
```

(continued)

TABLE C-1 (continued).

```
00690 VAR LABELS      CITIES,CITY IN WHICH CARS WERE TESTED/
00700                 VEHMAKE,VEHICLE MANUFACTURER/
00710                 VEHCLS,VEHICLE CLASS MOBILE1 CODE/
00720                 NUMCYL,NUMBER OF CYLINDERS/
00730                 FUELTYP,TYPE OF FUEL USED/
00740                 HC1,INITIAL HYDROCARBON READING PPM/
00750                 CO1,INITIAL CARBON MONOXIDE READINGS PERCENT/
00760 PRINT FORMAT    VEHMAKE(A)/FUELTYP(A)/CATALST(A)/
00770 COMMENT         OUTPUT FORMAT FOR VARIABLES
00780 SELECT IF       (((CITIES EQ 3) AND FACILITY NE 47) AND
00790                 MODELYR LE 67)
00800 COMMENT         SELECT DESIRED CITY AND MODEL YEARS AND DELETE ANY DATA
00810                 NOT GATHERED IN THE STATE OF MISSOURI
00820 IF              (HC1 LE 100) HCCODE=100
00830 IF              (HC1 GT 100 AND LE 200) HCCODE=200
00840 IF              (HC1 GT 200 AND LE 300) HCCODE=300
00850 IF              (HC1 GT 300 AND LE 400) HCCODE=400
00860 IF              (HC1 GT 400 AND LE 500) HCCODE=500
00870 IF              (HC1 GT 500) HCCODE=600
00880 IF              (CO1 LE 1.00) COCODE=1
00890 IF              (CO1 GT 1.00 AND LE 2.00) COCODE=2
00900 IF              (CO1 GT 2.00 AND LE 3.00) COCODE=3
00910 IF              (CO1 GT 3.00 AND LE 4.00) COCODE=4
00920 IF              (CO1 GT 4.00 AND LE 5.00) COCODE=5
00930 IF              (CO1 GT 5.00) COCODE=6
00940 COMMENT         THESE IF STATEMENTS CREATE TWO NEW VARIABLES AND CODE
00950                 THE INPUT TEST DATA
00960 VALUE LABELS    HCCODE (100)0-100PPM (200)101-200 PPM (300)201-300 PPM
00970                 (400)301-400 PPM (500)401-500 PPM (600)>500PPM/
00980                 COCODE (1)0-1% (2)1.01-2% (3)2.01-3% (4)3.01-4%
00990                 (5)4.01-5% (6)>5%/
01000 VAR LABELS      HCCODE, CODED INITIAL HYDROCARBON VALUES PPM/
01010                 COCODE,CODED INITIAL CARBON MONOXIDE VALUES %/
01020 TASK NAME       DESCRIPTIVE SUMMARIES OF DATA FOR SPECIFIED YEARS
01030 FREQUENCIES     GENERAL=VEHMAKE VEHCLS NUMCYL FUELTYP CATALST COCODE HCCODE
01040 OPTIONS         3,8
01050 READ INPUT DATA
01060 CROSSTABS       TABLES=COCODE BY HCCODE/COCODE BY HCCODE BY CATALST
01070 COMMENT         THE ABOVE STATEMENTS GENERATE SUMMARIES FOR INPUT DATA;
01080                 COMPARISONS OF TEST RESULTS FOR ALL VEHICLES AND FOR
01090                 CATALST VS NON-CATALST EQUIPPED VEHICLES
01100 *SELECT IF      (VEHCLS EQ 1)
01110 TASK NAME       VEHICLE CLASS 1
01120 CROSSTABS       TABLES=COCODE BY HCCODE
01130 *SELECT IF      (VEHCLS LE 2)
01140 TASK NAME       VEHICLE CLASSES 1 AND 2
01150 CROSSTABS       TABLES=COCODE BY HCCODE
```

(continued)

TABLE C-1 (continued).

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```
01160 *SELECT IF      (VEHCLS LE 3)
01170 TASK NAME       VEHICLE CLASSES 1,2 AND 3
01180 CROSSTABS       TABLES=COCODE BY HCCODE
01190 *SELECT IF      (VEHCLS LE 4)
01200 TASK NAME       VEHICLE CLASSES 1,2,3 AND 4
01210 CROSSTABS       TABLES=COCODE BY HCCODE
01220 COMMENT         THESE STATEMENTS GENERATE COMPARISONS OF CODED TEST DATA
01230                 FOR DIFFERENT VEHICLE CLASS GROUPS
01240 *RECODE         CO1(0.00 THRU 1.00=1)(1.00 THRU 2.00=2)(2.00 THRU 3.00=3)
01250                 (3.00 THRU 4.00=4)(4.00 THRU 5.00=5)(5.00 THRU 6.00=6)
01260                 (6.00 THRU 7.00=7)(7.00 THRU 8.00=8)
01270                 (8.00 THRU 9.00=9)(9.00 THRU HIGHEST=10)
01280 TASK NAME       FREQUENCY OF OCCURRENCE OF CODED CARBON MONOXIDE DATA
01290 FREQUENCIES     GENERAL=CO1
01300 OPTIONS         3
01310 *RECODE         HC1(0 THRU 100=100)(100 THRU 200=200)(200 THRU 300=300)
01320                 (300 THRU 400=400)(400 THRU 500=500)(500 THRU 600=600)(600
01330                 THRU 700=700)(700 THRU 800=800)(800 THRU 900=900)(900 THRU
01340                 1000=1000)(1000 THRU 1100=1100)(1100 THRU 1200=1200)(1200
01350                 THRU 1300=1300)(1300 THRU 1400=1400)(1400 THRU 1500=1500)
01360                 (1500 THRU 1600=1600)(1600 THRU 1700=1700)(1700 THRU 1800=
01370                 1800)(1800 THRU 1900=1900)(1900 THRU 2000=2000)(2000 THRU
01380                 HIGHEST=2100)
01390 TASK NAME       FREQUENCY OF OCCURRENCE OF CODED HYDROCARBON DATA
01400 FREQUENCIES     GENERAL=HC1
01410 OPTIONS         3
01420 COMMENT         THESE STATEMENTS WILL GENERATE THE DATA NEEDED TO EVALUATE
01430                 THE CHANGE IN MEANS FOR DIFFERENT PERCENTILES FOR EITHER HC
01440                 OR CO. THIS EVALUATION WILL REQUIRE RUNNING PROGRAM 'MEAN'
01450 FINISH
```

TABLE C-2. SPSS PROGRAM STATEMENTS FOR CALCULATION OF MEAN POLLUTANT VALUES

```
00250 RUN NAME        CHANGE IN MEAN FOR CO AND HC DATA 1975-1979 VEHICLES-K.C.-
00260 FILE NAME       MEAN
00270 VARIABLE LIST   CITY,FACILTY,MODELYR,VEHMAKE,VEHCLS,NUMCYL,FUELTYP,CATALST,
00280                 HC1,CO1
00290 INPUT MEDIUM    DISK
00300 N OF CASES      UNKNOWN
00310 INPUT FORMAT    FIXED(F1.0,F2.0,2X,F2.0,1X,A3,F1.0,3X,F1.0,A1,A1,F4.0,1X,
00320                 F4.2)
00330 VAR LABELS      HC1,INITIAL HYDROCARBON READINGS
00340                 CO1,INITIAL CARBON MONOXIDE READINGS
00350 PRINT FORMAT    CO1(2)
00360 SELECT IF       (((CITY EQ 1) AND (FACILTY NE 6 AND FACILTY NE 28) AND
00370                 MODELYR GE 75 AND MODELYR LE 79)
00380 TASK NAME       STATISTICS FOR ALL DATA IN SPECIFIED YEAR
00390 FREQUENCIES     GENERAL=HC1 CO1
00400 OPTIONS         2
00410 STATISTICS      1,5,6
00420 READ INPUT DATA
00430 COMMENT         THE THREE STATEMENTS ABOVE YIELD CALCULATED MEAN
00440                 STANDARD DEVIATION AND VARIANCE FOR THE CITY AND MODELYEAR
00450                 GROUP SELECTED
00460 *SELECT IF      (HC1 LE 600)
00470 TASK NAME       STATISTICS FOR 90TH PERCENTILE
00480 COMMENT         IF HIGHEST 10 PERCENT OF THE HC EMISSIONS ARE ELIMINATED
00490                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00500 FREQUENCIES     GENERAL=HC1 CO1
00510 OPTIONS         2
00520 STATISTICS      1,5,6
00530 *SELECT IF      (CO1 LE 5.5)
00540 TASK NAME       STATISTICS FOR 90TH PERCENTILE
00550 COMMENT         IF HIGHEST 10 PERCENT OF THE CO EMISSIONS ARE ELIMINATED
00560                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00570 FREQUENCIES     GENERAL=CO1 HC1
00580 OPTIONS         2
00590 STATISTICS      1,5,6
00600 COMMENT         THESE STATEMENTS YIELD CALCULATED MEAN,STANDARD
00610                 DEVIATION AND VARIANCE FOR PERCENTILES SPECIFIED
00620                 BY SELECTION OF APPROPRIATE HC AND CO CUTOFF
00630                 POINTS. THESE STATEMENTS WILL BE REPEATED IF
00640                 ADDITIONAL STATISTICS ARE DESIRED FOR OTHER
00650                 PERCENTILES
```

(continued)

TABLE C-2 (continued).

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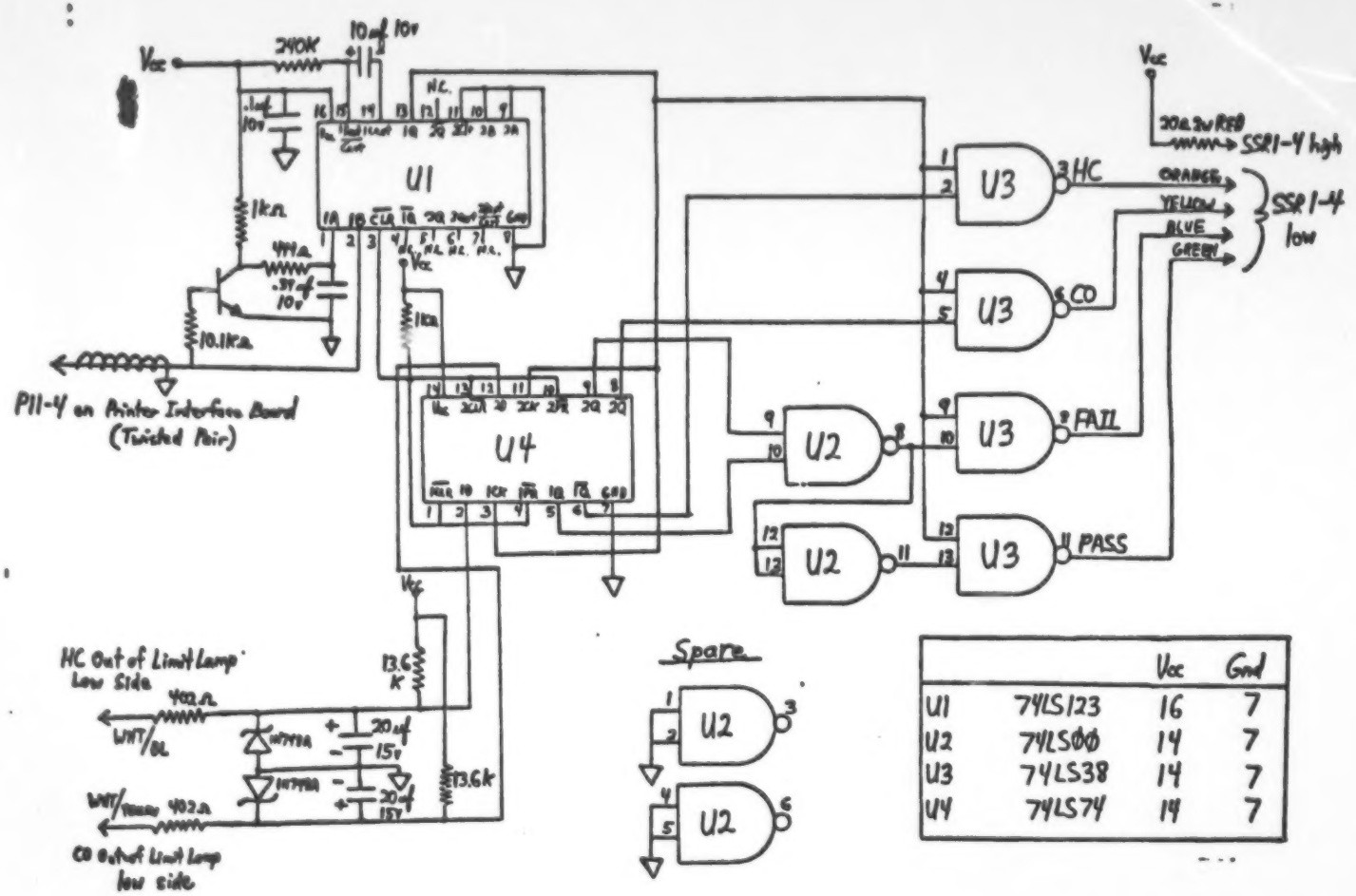
```
00660 *SELECT IF      (HC1 LE 350)
00670 TASK NAME       STATISTICS FOR BOTH PERCENTILE
00680 COMMENT         IF HIGHEST 20 PERCENT OF THE HC EMISSIONS ARE ELIMINATED
00690                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00700 FREQUENCIES     GENERAL=HC1 CO1
00710 OPTIONS         7
00720 STATISTICS      1,5,6
00730 *SELECT IF      (CO1 LE 4.5)
00740 TASK NAME       STATISTICS FOR BOTH PERCENTILE
00750 COMMENT         IF HIGHEST 20 PERCENT OF THE CO EMISSIONS ARE ELIMINATED
00760                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00770 FREQUENCIES     GENERAL=CO1 HC1
00780 OPTIONS         7
00790 STATISTICS      1,5,6
00800 *SELECT IF      (HC1 LE 259)
00810 TASK NAME       STATISTICS FOR 70TH PERCENTILE
00820 COMMENT         IF HIGHEST 30 PERCENT OF THE HC EMISSIONS ARE ELIMINATED
00830                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00840 FREQUENCIES     GENERAL=HC1 CO1
00850 OPTIONS         7
00860 STATISTICS      1,5,6
00870 *SELECT IF      (CO1 LE 2.5)
00880 TASK NAME       STATISTICS FOR 70TH PERCENTILE
00890 COMMENT         IF HIGHEST 30 PERCENT OF THE CO EMISSIONS ARE ELIMINATED
00900                 WHAT IS THE CHANGE IN MEAN FOR BOTH HC AND CO
00910 FREQUENCIES     GENERAL=CO1 HC1
00920 OPTIONS         7
00930 STATISTICS      1,5,6
00940 FINISH
```

APPENDIX D

WIRING DIAGRAM FOR MODIFICATION OF HAMILTON TEST SYSTEMS EMISSION ANALYZER



		Vcc	Gnd
U1	74LS123	16	7
U2	74LS00	14	7
U3	74LS38	14	7
U4	74LS74	14	7